IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Kitson et al.	
Serial No:	09/815,999	
For:	LIQUID CRYSTAL ALIGNMENT	
Filed:	March 23, 2001	
Examiner:	Hoan C. Nguyen	
Art Unit:	2871	Attorney Docket No.: 30001064-2

Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

Declaration Under 37 C.F.R § 1.132

I, Stephen Christopher Kitson, a citizen of the United Kingdom and a resident of 10 Stoney Stile Road, Alveston, Bristol, declare as follows.

1. I was awarded a first class honours degree in physics from the University of Exeter, UK, in 1991 and a PhD in physics also from the University of Exeter in 1995.

2. I am currently a research scientist with Hewlett-Packard Limited, a position I have held since 17th August 1998. Since that time I have worked extensively in the area of liquid crystal display research and development, focusing in particular on the alignment of nematic liquid crystal materials on microstructured surfaces. In my previous positions (research scientist at the Defence Evaluation and Research Agency, UK, 1996 – 1998, and as a post-doctoral research assistant at Exeter University, 1994 – 1996) I worked on different aspects of microstructured surfaces, in particular the novel optical properties of sub-wavelength structures.

3. I have read the specification and claims of US Patent Application No. 09/815,999 (the present application) for which I am named as an inventor, and the citations and objections raised by the Examiner at the USPTO and am familiar with their contents.

4. The present invention relates to a liquid crystal device having an alignment structure on an inner surface of a cell wall comprising a random or pseudorandom two-dimensional array of upstanding features, for example, posts. The liquid crystal alignment which can be achieved depends on the shape and orientation of the features, rather than the lattice arrangement. Alignment that is planar, tilted planar, or homeotropic may be obtained by suitable selection of the correct shape and orientation of the upstanding features, and a bistable alignment can also be achieved. Effectively randomizing the features in two dimensions over the entire area of the display enables optimization of the alignment without the undesirable optical diffraction effects that result from a regular lattice or grating. The desired alignment is produced without rubbing or evaporation of inorganic oxides, and hence without the problems associated with such production methods, as described in the introduction to the present application.

5. In my opinion, none of the prior art of record discloses or suggests the present invention as defined in the claims presently on file. My comments on each of the prior art documents cited in the latest Office Action (dated 26 December 2002) are given below.

Yasushi (JP5088177)

6. Yasushi describes how a conventional LC alignment film is formed by applying a polymer film to a substrate with electrodes thereon and rubbing the film with a fabric to produce a grooved polymer film. As is well known, LC molecules tend to align themselves in the groove direction, i.e. to "lie down" along the grooves in a planar or tilted planar alignment. This method has drawbacks including build-up of static electricity caused by the rubbing, damage to the surface and the accumulation on the surface of fibrous debris from the rubbing process. For large area displays, producing uniform alignment by this method is difficult. These drawbacks can cause display defects.

7. Yasushi discloses an alternative orientation treatment which is intended to replace the described prior art treatment. This involves providing on the substrate a polymeric orientation film that has periodic or non-periodic asymmetrical concave and convex shaped patterns. This is done by coating the substrate with a photoresist or photosensitive polyimide film, exposing the film through a mask having slits of a periodic pattern to produce a series of parallel rectangular walls, and then using ion beam etching to form the rectangular walls into asymmetric triangular-shaped walls, as shown in Figures 1 and 2.

8. As with the prior art, the film comprises a series of grooves that align the LC in a planar or tilted planar orientation. Yasushi found that symmetrical grooves (or walls) do not produce as good an alignment as asymmetrical grooves, which give results comparable to conventional rubbed polymer films, as shown in Figure 4 of Yasushi.

9. Yasushi discloses an alignment film which comprises a periodic or non-periodic series of parallel polymer walls of asymmetric shape that define between them corresponding parallel grooves of asymmetric shape. The parallel walls are arranged in a one-dimensional array, i.e., as a single row of unsymmetrical walls that span the display.

10. It should be noted that the symmetry or non-symmetry of each wall makes no difference to the fact that the walls are arranged in a one-dimensional array, i.e., the arrangement can be defined with reference to the position of each wall along a single axis on the surface of the substrate.

11. Unlike the present invention, Yasushi does not describe or suggest a two-dimensional array of upstanding features, but rather a conventional one-dimensional array in common with other prior art alignment means. Yasushi does not disclose means for achieving homeotropic alignment, bistable alignment, or different alignments in different regions of the display, all of which may be achieved using two-dimensional arrays of upstanding features, notably posts, as recited in the claims of the present application. Moreover, since the purpose of Yasushi is to provide a replacement for the conventional rubbed polymer grooved surface (by providing a grooved surface without rubbing), Yasushi provides no teaching or incentive to arrive at the claims of the present invention.

12. It should be noted that, in clear distinction from Yasushi, the independent claims of the present invention recite an array of features which can be defined with reference to the position of each feature on two axes. Yasushi is a one-dimensional array. The array of features of Yasushi is not a two dimensional array of upstanding features, as recited in the claims of the present invention.

Hiroshi (JP10148827)

13. Hiroshi relates to the use of random roughness to control the reflectivity of a reflecting layer by making it scatter light. The abstract states that a film is to be applied "to obtain uniform thickness of the liquid crystal layer 4". In my opinion, Hiroshi provides for an inorganic film such as silicon oxide or an organic film to be formed on the roughened surface of the metal reflector. Thus, the film "fills in the dips," and the roughness of the metal reflector is not "experienced" by the liquid crystal molecules. The liquid crystal molecules do not come into contact with the roughness or the metal film. The roughness therefore has no effect on the LC alignment. Instead the alignment is determined by the film that is formed on top of the roughened layer, which is a conventional alignment technology. Hiroshi does not describe or suggest a surface alignment structure integrated onto an inner surface of a first cell wall providing a desired alignment to molecules of the liquid crystal material, wherein the surface alignment structure comprises one of a random or pseudorandom two dimensional array of

upstanding features that are at least one of shaped and oriented to produce the desired alignment, as recited in the independent claims of the present invention. For this reason, Hiroshi is not relevant to the present invention except as general background art.

Masahiro (JP2211422)

14. The abstract of Masahiro states the purpose of the invention is "[t]o obtain a uniform contrast in a wide visual angle range by forming the surface of an electrode substrate on the side in contact with a liquid crystal layer to a rugged shape." In my opinion, Masahiro provides a liquid crystal display having uniform contrast over a wide angle of view. This is said to be achieved by providing a rugged substrate on which is formed an ITO (transparent conductor) film. My interpretation of the term "rugged" is that the surface is roughened. The roughness is achieved by an etching treatment such as hydrofluoric acid. It appears that the cell gap is modulated at random across the display. The optical response of an LC layer is determined by the product of its refractive index anisotropy (delta n) and the thickness of the layer (d). As the viewing angle changes, the layer thickness through which a user looks effectively increases. Consequently, the brightness of such displays changes at higher angles.

15. In Masahiro the microstructure is used to randomise the thickness of the layer and not to produce a desired alignment of the liquid crystal material, as recited in the claims of the present invention. The microstructure is actually quite large, having spacings of 10 to 500 μm and height up to 5 μm (see Operational Examples of Masahiro). The thickness of an LC layer in a typical device is of the order of 5 μm, so this variation in layer thickness is substantial. The result would be that at any angle the user would see a mixture of layer thicknesses on a fine pitch which will tend to even out the optical response giving a more uniform viewing angle, at the expense of reducing the overall brightness. I would expect some problems in achieving uniform switching because the LC will experience different electric field strengths in different regions of the display depending on the layer thickness (and therefore distance between electrodes) in the different regions.

16. Masahiro does not describe or suggest that the roughened surface provides an orientation effect on the liquid crystal material. In the present invention the surface alignment structure provides a desired alignment to the molecules of the liquid crystal material. The surface alignment structure comprises upstanding features that are at least one of shaped and oriented to produce the desired alignment. By controlling the shape of the upstanding features of the present invention, particular desired alignments can be achieved. The abstract of Masahiro states that the roughened surface is "[t]o obtain a uniform contrast in a wide visual angle range," as discussed above. In fact, in order to achieve alignment of the liquid crystal material, Masahiro subjects the ITO film to an orientation treatment. The abstract says that "The film is subjected

to an orientation treatment". This appears to be a reference to treatment of the ITO film with a conventional alignment agent, for example a rubbed polymer. My opinion is that it is this "orientation treatment", not the surface roughness underlying the ITO film, which produces an orientation of the LC molecules in Masahiro. This conclusion is supported by the examples in Masahiro which are of a twisted nematic (TN) display. As discussed in the introduction to the present application, at page 2, lines 7-10, a TN display requires the inner surface of each cell wall to be treated to produce a planar unidirectional alignment of the nematic director, with the alignment directions being at 90° to each other. In my opinion, such a planar unidirectional alignment would not be obtained by any effect of the roughened substrate produced by etching with hydrofluoric acid. Rather, such alignment would result from the "orientation treatment" to which the ITO is said to be subjected and which (absent any contrary indication) must be understood to be a conventional alignment treatment.

17. Thus I believe that Masahiro neither discloses nor suggests upstanding features that are at least one of shaped and oriented to produce a desired alignment, as recited in the claims of the present invention.

18. I can find no disclosure or teaching in any of the citations raised against the present application by the Examiner which shows that LC alignment should be achieved by means of a random or pseudorandom two-dimensional array of upstanding features on an inner surface of a cell wall, as recited in the claims of the present invention.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Signed:.....S. Kitson.....

STEPHEN CHRISTOPHER KITSON

Dated:.....27th May 2003.....